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ABSTRACT

In a third study of the Computer Aided Learning (CAL) system of the London Borough of Havering, England, the performance of students taught biology by a teacher using the CAL system was compared with that of students taught by the same teacher without the CAL system. Students were divided into two matched groups and compared using a pretest/posttest design. Students of all ability levels who used CAL appeared to gain a higher score on the posttest than equivalent students taught by the same teacher. About 75% of the students thought the CAL method was a satisfactory way to learn. (JY)

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ED 129281

CAL

COMPUTER AIDED LEARNING

REPORT

TRIAL 3 : AUTUMN 1973

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
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THE LONDON BOROUGH OF HAVERING

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CONTENTS

INTRODUCTION

This document is a description of the Third Trial using the C.A.L. System, it follows the same format as the description of the Second Trial.

The main objective of the Trial was to compare the performance of students taught by a teacher using the C.A.L. System with that of students taught by the same teacher without the C.A.L. System.

DURATION : Teaching time was five double lessons at weekly intervals. The length of these periods varied slightly from school to school and was between 65 and 70 minutes. In addition there was a homework each week lasting for 30 minutes.

Testing time for the pre and post course tests is 65 minutes each.

The minimum total course length is 7 weeks but in some schools the course lasted longer because half term holidays, royal weddings and other happy occasions interceded.

The following schools took part:

School	Class Description	Class Size CAL	Class Size NON-CAL
Dury Falls School	Secondary (Girls)	17	21
Harrow Lodge	Secondary (Mixed)	29	30
	Secondary (Boys)	28	29
Maylands School	Secondary (Girls)	31	27
The Campion School	Grammar (Boys)	29	33
The Chafford School	Secondary (Mixed)	34	33
Royal Liberty School	Grammar (Boys)	21	20
Frances Bardsley School	Grammar (Girls) - Non Cal Class	33	25
	Secondary (Girls) - Cal Class		
		222	218

The class sizes listed above are the student numbers on the class register and record the maximum number of students present in each class for each lesson during the trial. The number of students present for the pre and post tests, and therefore available for statistical treatment, is less than that listed above and is as follows:

School	Number of students completing pre and post tests	
	CAL Class	NON CAL Class
Dury Falls School	13	16
Harrow Lodge School	25	23
	24	25
Maylands School	27	26
The Campion School	27	32
The Chafford School	25	27
Royal Liberty School	21	20
Frances Bardsley School	30	23
Totals	192	192

A further sampling of the above sample was made by pairing students from the CAL class with equivalent students from the non-CAL class, the matching being based upon AGE
SEX
PRETEST 7 SCORE
SAME CLASS TEACHER

This produced a matched pairs sample from the schools as follows:

School	Number of matched students	
	CAL Class	NON CAL Class
Dury Falls School	5	5
Harrow Lodge School	16	16
	16	16
Maylands School	13	13
The Campion School	24	24
The Chafford School	13	13
Royal Liberty School	16	16
Frances Bardsley School	12	12
Totals	115	115

The subdivision of the unpaired statistical sample according to sex is as follows:-

	GIRLS	BOYS
CAL GROUP	77	115
NON CAL GROUP	86	106
TOTALS	163	221

The subdivision of the matched pairs sample according to sex is as follows:-

	GIRLS	BOYS
CAL GROUP	34	81
NON CAL GROUP	34	81
TOTALS	68	162

The apparently greater loss of girls than boys in the student pairing process is due mainly to the original pairing of classes taught by each teacher. In three cases girls classes at opposite ends of the ability spectrum were matched so that the number of overlapping students was small.

One of the original objectives of the research project stated that the team would attempt some kind of comparison between what are described as traditional teaching methods and the methods of the CAL system. It seems that such a comparison can proceed along two paths; one leading to a description of the differences in procedures of the two methods, the other to the differences in effects of these methods. This note is concerned primarily with the effects of the two methods.

COMPARING TEST RESULTS

Theoretically, the idea of testing the effectiveness of two different teaching methods regarding student examination performance seems a relatively simple matter. All we need to do is to pretest two matched groups of students in the subject matter to be taught, teach one group by one of the two methods to be compared and the other group by the other method, post test the students and compare the results. In practice, two main difficulties present themselves:

i. ensuring that the two groups of students are matched for those characteristics which are likely to be relevant in affecting any changes in behaviour produced by the teaching methods under test.

ii. ensuring that the terminal behaviours of the two teaching methods are similar enough to be compared by the same tests.

With regard to matching students our experience in Trials 1 and 2 suggests that the following characteristics may have important effects on student performance when using the CAL system:-

SEX

TEACHER

SCHOOL

PRE-KNOWLEDGE OF SUBJECT MATTER

It seems likely that different teaching methods produce different terminal behaviours in the students subjected to them. This seems

inevitable but it can be minimised if effort is expended to assure that terminal objectives for each stage of the teaching procedure are the same for each of the teaching methods.

The procedure we adopted is as follows:

1. We did not try to define "traditional" teaching methods too closely but accepted any method as "traditional" if it took place inside the classroom with the teacher as the primary source of information. Thus for each stage of the teaching strategy adopted the teacher was the sole arbiter of the teaching intensity, teaching level and success. The class moved on to the next topic when the teacher thought they were ready for it.
2. A teacher is selected who is capable of teaching to a set of objectives using the traditional methods and the CAL individual learning method.
3. Two approximately matched classes of students are selected; one class to be taught by the traditional method, the other by the CAL learning method. The teacher decides which of his two classes will be taught by the CAL method.
4. The teacher is asked to read through all the CALTS of the three ability levels with the class to be taught by "traditional" methods in mind.
5. The teacher selects for the class a series of work tasks from the three courses available to cover the content of the courses. These can be at any level the teacher thinks is suitable, and should be enough for five weeks work.
6. For each of the CALTS selected by the teacher for his class he receives a list of CALT objectives.
7. The teacher teaches his class by whatever method he thinks suitable for each of the objectives, handing out the CALT post tests to the students as tests if he thinks it desirable.
8. The other class is taught using the CAL system with the same teacher in charge.
9. Before the course starts each student is pre-tested with tests 7 and 9, and post tested five weeks later at the end of the course using the same tests.

In a pilot study we ran of the above procedure the main difficulty encountered by the two teachers concerned was in timing the course so that the syllabus was completed. We overcame this problem in Trial 3 by starting each teacher on the CAL class first so that the equivalent non-CAL class was taught later in the week.

Each class was post tested one week after completion of the fifth and final class lesson. T[illegible]

A full description of the teaching and learning activities occurring in a typical CAL class is provided in our booklet entitled "CAL in the Classroom"(1973

The teaching methods used on the non-CAL classes varied from teacher to teacher and ranged from the more traditional lecture/demonstration by the teacher approach, to the students conducting their own experiments in small groups. In fact any method which the teacher felt at ease with was used with the non-CAL class. This means of course, that there was a much greater variety in teaching methods used on the non-CAL groups, the common denominator being, that the teacher was the primary source of information. The following seem to be the major areas of difference between what goes on in a CAL class and in a normal science class.

1. In the non-CAL class the teacher is the primary source of information whereas in the CAL class this is not the case. Here the teacher does provide students with information but this is mainly in response to one or more students who ask for information.

2. In the non-CAL classroom the student is often a passive receiver of information. This is less so in the CAL classroom where the student is responsible for the organisation of his own work activities and is encouraged to seek information where necessary from experiments or the teacher.

3. In the non-CAL classroom classwork tends to be aimed at the "class average" and not at each individual. The CALTS in CAL classes meet more closely the individual needs of the student to whom they are allocated by the computer. This contrasts with the non-CAL classroom where all students are asked to do the same classwork but with varying degrees of success.

4. In the non-CAL classroom students are required to work at a pace which does not leave the slowest student too far behind. In the CAL classroom students can work at their own pace.

5. Because of organisational difficulties scientific practical work leans more heavily on teacher demonstration rather than individual student work in the non-CAL class compared with the CAL classroom.

6. In a non-CAL class the academic hierarchy is set early in the life of the class and remains a characteristic for the entire life of the class. The different student working methods of a CAL-class are likely to produce a real or imagined (in the minds of the students) change in this heirarchy which in turn influences students attitudes to the CAL system.

Teachers of the non-CAL classes were allowed to make use of any of the special pieces of apparatus used in the CAL course including a set of slides on the topic of energy release. As far as aids were concerned the only thing that teachers were asked not to do was to hand out the teaching CALTS to the non-CAL class.

Each class was post tested, using tests 7 and 9 again, one week after completion of the fifth and final class lesson. A matched pair sample was produced from the results of pre-and post test 7 using the following procedure:-

Matched pairs selection procedure

1. Eliminate from sample all students who were not present for both pre- and post tests.
2. Rank each class separately on the basis of pretest 7 score.
3. Match students from a teachers CAL class with those from his non-CAL class on basis of sex and pretest 7 score. The difference in pre test 7 scores allowed is ± 3
4. Compare the two samples produced for each teacher for differences in mean and variance on the pretest scores.

Results for the matched pairs sample are recorded below.

RESULTS: MATCHED PAIR SAMPLE

The data used in this section is derived from the following sources:

1. Pretest 7
2. Pretest 9
3. Post test 7
4. Post test 9
5. Student Opinion Questionnaire

Pre/Post Test 7

Results for matched pair sample - 115 students in each group.

	E	C
MEAN	62.209	61.809
VARIANCE	279.487	277.095
S.D.	16.718	16.646

Pretest 7

	E	C
MEAN	73.548*	68.791*
VARIANCE	274.422	316.355
S.D.	16.566	17.786

Post test 7

* The difference between these mean is significant (5% level).

The results for each ability level group are as follows:-

LEVEL 1 (48 Students in each group)

	E	C
MEAN	78.354	77.896
VARIANCE	30.395	25.386
S.D.	5.513	5.038

Pretest 7

	E	C
MEAN	86.167*	83.771*
VARIANCE	48.805	44.344
S.D.	6.986	6.659

Post test 7

* The difference between these two means is significant at the 10% level.

LEVEL 2 (62 students in each group)

	E	C
MEAN	52.532	52.129
VARIANCE	99.539	102.886
S.D.	9.977	10.143

Pretest 7

	E	C
MEAN	66.323*	59.984*
VARIANCE	190.089	201.080
S.D.	13.787	14.180

Post test 7

* These means are significantly different (5% level).

LEVEL 3

As there are only 5 pairs of level 3 students in the matched pairs sample then the results are not recorded in this report.

GAIN: TEST 7

The gain of students completing pretest and post test 7 is calculated by subtracting their pretest scores from their post test scores. Results for the matched pair sample are as follows:-

	E	C
MEAN	11.339*	7.470*
VARIANCE	84.676	63.553
S.D.	9.202	7.972

* The difference between these means is highly significant (1% level).

The results for each ability level group are as follows:-

LEVEL 1 (Number of students = 48 per group)

	E	C
MEAN	7.812	5.875
VARIANCE	43.819	39.401
S.D.	6.620	6.277

No significant difference between the means.

LEVEL 2 (Number of students = 62 per group)

	E	C
MEAN	13.790*	8.758*
VARIANCE	87.424	76.409
S.D.	9.350	8.741

* The difference between these means is highly significant (1% level).

The mean score on pretest 7 is approximately 56%. If the sample is divided into two groups, the first having scores of 56% and above, the second having scores of 55% or below, then the following results are obtained from the gain scores of the latter group on test 7.

	E	C
MEAN	13.738*	8.976*
VARIANCE	110.717	84.452
S.D.	10.522	9.190

* The difference between these means is significant (at 5% level)

42 Students in each group

Pre/Post test 9

Results for the matched pair sample - 115 students in each group.

	E	C
MEAN	17.591	18.313
VARIANCE	104.537	101.641
S.D.	10.224	10.082

Pretest 9

	E	C
MEAN	35.139*	30.817*
VARIANCE	297.389	236.184
S.D.	17.245	15.368

Post test 9

* The difference between these means is significant (5% level).

The results for each ability level group are as follows:-

LEVEL 1 (48 students in each group)

	E	C
MEAN	24.146	26.042
VARIANCE	103.333	129.915
S.D.	10.165	11.398

Pretest 9

	E	C
MEAN	48.792*	41.583*
VARIANCE	239.665	169.493
S.D.	15.481	12.629

Post test 9

* The difference between these means is significant (5% level).

LEVEL 2 (62 students per group)

	E	C
MEAN	13.661	13.726
VARIANCE	52.998	54.844
S.D.	7.280	7.406

	E	C
MEAN	25.823	23.323
VARIANCE	113.501	153.347
S.D.	10.654	12.385

GAIN: TEST 9

The gain of students completing pretest and post test 9 is calculated by subtracting their pretest scores from their post test scores. Results from the matched pairs sample are as follows:-

	E	C
MEAN	17.548*	12.670*
VARIANCE	144.387	117.995
S.D.	12.016	10.863

* The difference between these means is highly significant (1% level).

The gains for each ability level group are given below:-

LEVEL 1 (Number of students = 48 in each group)

	E	C
MEAN	24.646*	16.479*
VARIANCE	130.687	91.083
S.D.	11.432	9.544

* The difference between these means is highly significant (1% level)

LEVEL 2 (Number of students = 62 in each group)

	E	C
MEAN	12.516	9.903
VARIANCE	94.314	124.765
S.D.	9.712	11.170

Based on pretest 7 the sample can be divided into two groups; one group contains students with a score of 56% or above, the other group contains students with a score of 55% and below. The following results are from the test 9 gain scores of the latter group.

	E	C
MEAN	11.024	8.714
VARIANCE	59.595	74.633
S.D.	7.720	8.639

42 students in each group

Student Opinion Questionnaire

At the end of each trial, after they had completed their post tests, CAL students were given an opinion questionnaire containing six questions. They were asked to select one from the three alternative answers given for each question. In addition students were asked to describe in their own words any opinions they had about the CAL course they had recently completed. These results are compiled from the questionnaires of the 231 students who completed the course.

The results for each of the six questions in the students questionnaire are listed below:-

1. During CAL Biology I was given

   A. just enough work to last through the lesson.

   B. too much work.

   C. too little work.

	CAL GROUP		
	A	B	C
Mean Percentage	58.9	25.5	15.6

2. During CAL Biology the work I was given was

   A. too difficult for me.

   B. too easy for me.

   C. about right for me.

	CAL GROUP		
	A	B	C
Mean Percentage	6.1	3.9	90.0

3. During CAL Biology most of the work I was given was

   A. very interesting.

   B. interesting.

   C. not very interesting.

	CAL GROUP		
	A	B	C
Mean Percentage	18.6	54.1	27.3

4. During CAL Biology I was given

   A. too much homework.

   B. just enough homework.

   C. too little homework.

	CAL GROUP		
	A	B	C
Mean Percentage	15.1	59.7	25.1

5. CAL Biology lessons are

   A. as interesting as ordinary lessons.

   B. more interesting than ordinary lessons.

   C. less interesting than ordinary lessons.

	CAL GROUP		
	A	B	C
Mean Percentage	25.1	49.3	25.5

6. During CAL Biology lessons I think I learn

   A. as much as in ordinary science lessons.

   B. less than in ordinary science lessons.

   C. more than in ordinary science lessons.

	CAL GROUP		
	A	B	C
Mean Percentage	34.6	21.2	44.2

DISCUSSION OF TRIAL 3 RESULTS

The sample of students used in Trial 3 contained a considerably larger number of high ability students than the samples used in either Trial 1 or Trial 2, as is shown by pre test 7 mean scores:-

TRIAL 1..... 52.1 %
TRIAL 2..... 56.1 %
TRIAL 3..... 62.1 %

This particular sample was chosen for two reasons:

1. To load the trial against the CAL system; the results from trials 1 and 2 indicated that the CAL system gave the most benefit to students of below average ability.

2. To enable us to collect more data about the reaction of high ability students, particularly boys, to the CAL system.

The notes on the interpretation of tests 7 and 9 described in section 8 of our last report (The Development of Educational Material. The Second Report May 1973) also apply to the discussion of the results of trial 3.

The results of trial 3 have shed an interesting light on the predictive value of Test 7. This test is used to divide the sample into three ability level groups. Now if this test has any value in a predictive role there should be a positive correlation between a student's performance on the test and his performance on similar tests. In trial 3 the correlation coefficient between scores of pre test 7 and post test 9 for girls in the CAL classes is 0.77. This contrasts with that for the girls in the non-CAL class of 0.67. A similar state of affairs exists for the boys with a correlation coefficient of 0.73 for the CAL classes contrasting with 0.67 for the non-CAL classes. Thus it appears that test 7 has a higher predictive power for students working within the CAL system than it has for students working on teaching material outside the CAL system.

The results from trial 3 of the CAL system indicate the following:

1. Students taught by a teacher using the CAL system as a management aid are likely to gain higher scores on tests 7 and 9 than equivalent students taught to the same objectives by the same teacher but without the CAL system in a similar time period.

2. The advantage described above and gained by CAL students over non-CAL students appears to operate over the whole student ability range.

3. The same advantage applies to both CAL boys and girls compared with non- CAL boys and girls. This is shown in the tables below:

TRIAL 3 MATCHED PAIRS

		TEST 7			TEST 9		
		PRE	POST	GAIN	PRE	POST	GAIN
CAL GIRLS	MEAN	54.73	68.71	13.97*	14.235	29.50	15.26
(N = 34)	S.D.	14.62	16.39	9.91	7.252	13.76	10.87
NON-CAL GIRLS (N = 34)	MEAN	54.73	61.62	6.88*	14.147	29.26	15.41
	S.D.	14.64	18.33	7.74	8.048	15.73	12.09

*The difference between these means is highly significant (1%)

TRIAL 3 MATCHED PAIRS

		TEST 7			TEST 9		
		PRE	POST	GAIN	PRE	POST	GAIN
CAL BOYS	MEAN	65.35	75.58	10.23	19.00	37.51	18.51*
(N = 81)	S.D.	16.55	16.212	8.65	10.94	17.99	12.34
NON-CAL BOYS (N = 81)	MEAN	64.79	71.80	7.71	20.18	31.59	11.52*
	S.D.	16.54	16.66	8.05	10.22	14.99	10.09

* The difference between these means is highly significant

4. The results of the student opinion questionnaire differ but slightly from those of the computer routed students in trials 1 and 2. The most noticeable difference is revealed in those questions (1 and 4) concerned with the quantity of work allocated by the computer. In trial 3 a greater percentage of students complained that they did not receive enough work to keep them fully occupied, particularly homework. This variation is

probably a reflection of the constitution of the trial 3 sample which contains a larger proportion of ability level 1 boys than the samples for trials 1 and 2.

5. The opinion questionnaire confirms that girls prefer the CAL system to a greater extent than boys do, as was indicated by the results of trials 1 and 2. The table below contains an analysis of the relevant data.

TRIAL 3 Students for and against CAL
Subdivided on sex

	FOR	AGAINST	SAMPLE SIZE
BOYS	62.9%	37.1%	132
GIRLS	74.7%	25.3%	87

6. Analysis of the student opinion questionnaire on the basis of ability level indicates that the proportion of students who are happy to accept the CAL system as a satisfactory method of learning is similar for each of the ability levels. The analysis table is as follows:-

TRIAL 3 Students for and against CAL
Subdivided on ability level

ABILITY LEVEL	FOR	AGAINST	SAMPLE SIZE
Level 1	73.7%	26.3%	57
Level 2	64.7%	35.3%	133
Level 3	68.9%	31.1%	29

SOME STUDENTS DO NOT LIKE CAL BIOLOGY

Somewhat more than 25% of the students who have taken part in the trials of the CAL Biology system do not like the system compared with the way in which they are normally taught Biology. At the end of each trial the students were asked to describe in their own words their likes and dislikes about the CAL system. Analysis of the comments written by the 25% of the students who do not like the CAL system reveals that fourteen main reasons are commonly listed by these students for not liking the system. These reasons are as following:

1) Boring work

It is not clear what the students mean by the word boring, but the word is used very often by students who do not like the CAL system.

2) Monotonous presentation

Many students feel that the method of presentation of the CAL work is too monotonous. When the system was being designed it was decided to present most of the work to the student in the form of short booklets with the instructions in a form resembling a programmed text. This was the cheapest form of presentation, but it was not known at the time how long students could put up with this form of presentation without becoming disatisfied. There seems no doubt that if a variety of presentation modes were adopted then this 25% of the students not liking the CAL system could be reduced.

3) Work too simple

Many of the more able students decided that the work they were being asked to do was on the whole too easy. In particular many disliked the procedure of finding the correct answer to the various questions they were asked, in the frames following the questions. Students complained that other students would get the questions correct even if they did not try very hard and this seemed unfair to them. This complaint was particularly prevalent amongst students who in normal lessons were at the top of the class. It might be worth while in the future to ask students whether or not they want the correct answers in the CALTS which they are given, and if they don't then provide them with CALTS which do not contain the answers.

4) Course too long

Some students thought that the course was too long. This complaint can be linked to complaint No.2. Some students suggested that the course would be less monotonous and less tiring if it was alternated on a weekly basis with lessons of the normal teacher presented type.

5) Do not learn enough

This complaint is linked with complaint No.4. Some students thought that they did not learn enough in the amount of time spent on the course compared with what they would in a normal Biology lesson.

This complaint is connected in part with complaint 2 concerning mode of presentation. When used correctly the structured CALTS do enable about 70% of students using them to achieve about 70% correct answers on the post CALT tests. However, for a variety of reasons, only one of which is boredom, students do not always use the CALTS in the prescribed manner and so do not always achieve mastery of the CALT subject matter. Recent work with the Individually Prescribed Instruction program, developed by the Learning Research and Development Centre of the University of Pittsburgh, described by H.J.Oles (1973) has revealed a high degree of student misuse of self-evaluation opportunities provided by the program. Of the two hundred and thirty-eight students in the study only 12.1% used the self scoring process in the ways set forth by the program developers.

Finally, the results of trial 3 as a whole suggest that students learn at least as much in CAL lessons as they would in normal Biology lessons even if they do not think so.

6) Not enough work

Students work at different rates and the amount of work completed by one student in a lesson can vary considerably from that completed by his peers. Although a mechanism is incorporated in the system to provide each student with enough work to fill the lesson the mechanism is not perfect and for a small number of students not enough work is provided. This problem is made more difficult by the fact that students do not devote enough time to making sure that they have done the work correctly, in many cases simple completion of the task in the fastest time seems to provide more satisfaction than getting all the work right.

This is particularly prevalent in grammar schools. It is essential that this problem of work allocation is solved as it is a major stumbling block on the road to general acceptance of CAL systems in schools (see Banks 1969)

7) Too much rushing around.

Some students thought that they spent so much of the lesson rushing around searching for apparatus and deciding what to do, that they did not have enough time to finish the work set. Certainly the atmosphere in most classes during a CAL session is busy and this active environment does not seem to appeal to all students.

8) Class control too weak

This complaint is connected with complaint No.7. Some students complained that some of their peers did not work hard enough during CAL lessons and wasted too much time fooling around. This disturbed some students and prevented them from working and consequently they preferred the normal class situation in which the teacher control was more obvious.

9) Do not like working alone.

Many students do not like working by themselves, and dislike being responsible for their own work. Some students mentioned that they missed the opportunity to talk with their friends who were often doing different work and did not welcome disturbance. This difficulty might be overcome by arranging that some students work in pairs.

10) Not enough attention from the teacher

Many students who do not like working alone also claimed that they did not get enough attention from the teacher. This may be connected with the fact that in many normal Biology classes a relatively small number of students are able to monopolise the teacher's attention. However, it also seems likely that the CAL system as it stands at the moment does not allow the teacher to spend enough time with individuals. This is supported by the fact that many teachers reported that they were literally rushed off their feet during CAL sessions.

11) Work not relevant

Many of the low ability students did not feel that the work they were asked to do had anything to do with Respiration or even Biology. Some teachers have remarked that occasionally

students get so involved with the details of the work they are doing (particularly the analysis of gases) that they do not see its relevance in the context of the course as a whole. A similar state of affairs has been reported in other attempts to program scientific laboratory work (e.g. Powell and French 1972)

12) Too many tests

Some of the low ability students complained that there were too many tests in the system and that they had to do too much reading.

13) Work is silly

Some of the high ability students complained that many of the things they were asked to do and read were childish and silly. Some thought that most of the jokes in the system were stupid.

14) Too much writing and paperwork

Many of the low ability students complained that they had too much writing to do and had to read too much written paper work. This complaint is similar to and connected with Complaint No.2 concerning monotonous presentation.

Finally, it should be recorded that some students form temporary mental attachments to their teachers and regard the CAL system as some kind of threat to their teachers. Loyally, these students automatically oppose the CAL system. This response is particularly marked when the teacher is clearly physically attractive and of the sex opposite to that of the students. As might be expected these last statements are the writer's interpretation of comments written by various students and not the comments themselves.

It should be noted that there is no evidence to suggest that students who profess a dislike of this CAL system do any worse on the post tests than those students who like it. A similar state of affairs has been reported in other studies particularly in the field of programmed learning (Ellams 1969).

In addition, it is likely that a proportion of these students who do not like the CAL system are allergic to school and education generally. This is perhaps particularly important in the age group of the sample which is approaching the age (14 and 15 years) when differences between industrious and allergic pupils are most marked. (Sumner and Warburton 1972)

TRIAL 3 CAL GROUP PRETEST 7

0 -9		
10 - 19		
20 - 29	XXX XXX XXX	3
30 - 39	XXXXXXXX XXXXXXXX XXXXXXXX	8
40 - 49	XXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXX	22
50 - 59	XXXXXXXXXXXXXXX XXXXXXXXXXXXXXX XXXXXXXXXXXXXXX	15
60 - 69	XXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXX	20
70 - 79	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXX	30
80 - 89	XXXXXXXXXXXXXXX XXXXXXXXXXXXXXX XXXXXXXXXXXXXXX	16
90 - 99	X X X	1

TRIAL 3 CAL GROUP POST TEST 7

0 - 9		
10 - 19	X X X	1
20 - 29		
30 - 39	XXXX XXXX XXXX	4
40 - 49	XXXXXXX XXXXXXX XXXXXXX	7
50 - 59	XXXXXXXXXXXXX XXXXXXXXXXXXX XXXXXXXXXXXXX	13
60 - 69	XXXXXXXXXXXXX XXXXXXXXXXXXX XXXXXXXXXXXXX	13
7 - 79	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXX	31
80 - 89	XXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXX	26
90 - 99	XXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXX	20

TRIAL 3 CAL GROUP PRETEST 9

0 - 9	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	30
10 - 19	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	41
20 - 29	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	29
30 - 39	XXXXXXXXXXXXX XXXXXXXXXXXXX XXXXXXXXXXXXX	12
40 - 49	XXX XXX XXX	3
50 - 59		
60 - 69		
70 - 79		
80 - 89		
90 - 99		

TRIAL 3 CAL GROUP POST TEST 9

0 - 9	XXXX XXXX XXXX	4
10 - 19	XXXXXXXXXXXXXXX XXXXXXXXXXXXXXX XXXXXXXXXXXXXXX	16
20 - 29	XXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	35
30 - 39	XXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXX	19
40 - 49	XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX	11
50 - 59	XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX	17
60 - 69	XXXXXXXXX XXXXXXXXX XXXXXXXXX	9
70 - 79	XXXX XXXX XXXX	4
80 - 89		
90 - 99		

TRIAL 3 NON CAL GROUP PRETEST 7

0 - 9		
10 - 19		
20 - 29	XXX XXX XXX	3
30 - 39	XXXXXXXX XXXXXXXX XXXXXXXX	8
40 - 49	XXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXX	22
50 - 59	XXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXX	18
60 - 69	XXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXX	17
70 - 79	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	30
80 - 89	XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX	16
90 - 99	X X X	1

TRIAL 3 NON CAL GROUP POST TEST 7

0 - 9		
10 - 19	X X X	1
20 - 29	XXX XXX XXX	3
30 - 39	XXXX XXXX XXXX	4
40 - 49	XXXXXXXXXXX XXXXXXXXXXX XXXXXXXXXXX	11
50 - 59	XXXXXXXXXXXXXXX XXXXXXXXXXXXXXX XXXXXXXXXXXXXXX	16
60 - 69	XXXXXXXXXXXXXX XXXXXXXXXXXXXXX XXXXXXXXXXXXXXX	15
70 - 79	XXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXX	25
80 - 89	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	31
90 - 99	XXXXXXXXX XXXXXXXXX XXXXXXXXX	9

TRIAL 3 NON CAL GROUP PRETEST 9

0 - 9	XXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXX XXXXXX XXXXXXXXXXXXXXXX	24
10 - 19	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	43
20 - 29	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	37
30 - 39	XXXXXXX XXXXXXX XXXXXXX	7
40 - 49	XXX XXX XXX	3
50 - 59	X X X	1
60 - 69		
70 - 79		
80 - 89		
90 - 99		

TRIAL 3 NON CAL GROUP POST TEST 9

0 - 9	XXXXXXXXX XXXXXXXXX XXXXXXXXX	9
10 - 19	XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX	16
20 - 29	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	36
30 - 39	XXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXX	25
40 - 49	XXXXXXXXXXXXXXX XXXXXXXXXXXXXXX XXXXXXXXXXXXXXX	15
50 - 59	XXXXXXX XXXXXXX XXXXXXX	7
60 - 69	XXXXXX XXXXXX XXXXXX	6
70 - 79	X X X	1
80 - 89		
90 - 99		

In the report "Off-Line Computer Aided Learning Project. The Development of Educational Material. The Second Report" statistics about the operational aspects of the C.A.L. system were given. A very similar system has been used in this third trial but the following modifications have been made since the second trial.

a) Part of the main suite of programs has been "chained" to reduce operator intervention.

b) In trial 2 only 50% of the students were routed. In trial 3 this figure increased to 100%.

c) The routing algorithm has been modified to speed up the process of routing students.

d) Output from the response input program has been changed to the lineprinter

e) Input to the file set up and start of marking program (CAL 6) has been modified.

The total population used in these statistics is 253 students from comprehensive schools. Class sizes were as follows.

21, 17, 29, 29, 30, 31, 29, 34, 33

During the trial the calculated cost of production (same form of calculation as used last time) for each week varied from £22-58 to £15-57 per hundred student hours of material. This variation is shown below.

Week No.	1	2	3	4	5	6
Cost £	22.58	21.61	19.10	20.67	15.57	16.94

Some of this variation is explained by the operators and teachers gaining more experience with using the system. However, the reduction in week 5 is due to a high proportion of Teacher allocations being made (reducing the computer time spent on routing) and in week 6 all the final output from the system (our equivalent of "end of term reports") is included.

The cost of producing 100 student hours material in trials 2 and 3 are compared in the table below.

	Trial 2	Trial 3
Initial Checking and Punching	3.78	3.63
Checking	2.27	2.29
Correcting	1.00	1.01
Run Time and Dumping	12.97	11.44
Splitting up and making up	1.57	1.09
TOTAL	21.59	19 .46

All entries are in £s.

It will be seen that principle savings have been made in computer time and the splitting up and making up operations.
The saving of computer time is due to the changes described above.

The splitting up and making up costs will be removed in a 'non' research environment. Thus a production system cost will be £18-37 per 100 student hours. Our expectation is that we should be able to improve on this situation. We did in the latter part of the course.

The costs of the first three items in the table have not altered significantly during the two trials. Modification to the computer system are in hand so that we should be able to reduce those items significantly at the expense of increasing the computer time.

Even if the overall costs are increased temporarily the labour costs tend to increase with time, whilst the amount of processing one can do on a computer for £1 increases from year to year; this all means that tending to place costs in categories which are not labour intensive will contribute to the long term cost reduction objectives of the system.

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